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Studies on milk preservatives.

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The object of this series of studies is to investigate the value of various antiseptics and their usefulness as milk preservatives; especially relating to the preservation of composite samples as used in creameries. Closely allied with this subject are the study and investigation of those substances which are on the market and are sold for the purpose of preserving milk, butter and other foods; these substances being sold under the name of a certain brand and their composition kept secret from the purchaser. It is also our intention, if time will allow the work to be carried on, to undertake the examination of the action of these substances used as food preservatives as related to digestion. This study will be the first of a series in which it is hoped results will be presented which will be of value to those interested in dairy lines.

THE USE OF FORMALDEHYDE AS A MILK PRESERVATIVE.

The results presented here must be regarded as a preliminary study and will be continued, so that the study may be a thorough one upon the subject.

In England during the last few years, there has been used very large quantites of a substance known as formaline, and as the result of this use in England the substance is to a certain extent being introduced into this country, but under other names than the above. The substance is said to be nonpoisonous and is used largely to preserve milk in possession of city milkmen so that it will not become sour for some days, this of course depending upon the temperature of the weather. The substance called formaline is what is known to chemists as a solution of formaldehyde, the solution largely used being a five per cent. solution.

Pure formaldehyde is a gas at ordinary temperatures and when this gas is passed or allowed to bubble through water, the gas is absorbed and taken up in the water to the extent of forty per cent., this solution is what is sold commercially as "Formaldehyde forty per cent.," and is the substance used in these experiments.

For those interested it may be well to say that an aldehyde is a substance which is a product between an alcohol and an acid, for example, when cider is changed to vinegar a chemical change takes place and the alcohol which is present in the cider is changed to an acid called acetic acid and the characteristic sour taste of vinegar is due to the presence of this acid. In this change we generally recognize the alcohol at the commencement of the process and the final product, the acid, but there is formed between these two products a substance which is called an aldehyde, that is the alcohol loses part of its hydrogen and becomes an aldehyde; the aldehyde takes up oxygen and changes to the acid. The aldehyde formed in this change is called acetaldehyde to distinguish it from other similar bodies.

If we take a substance which is known as wood alcohol it can be changed into an acid similar to acetic acid, and as we found in the case of the alcohol in cider changing to an acid and that a substance called an aldehyde is formed, we find here that between the wood alcohol and the acid which is called formic acid, a body having the nature of an aldehyde. We have seen that where the aldehyde changed to acetic acid that it was called acetaldehyde and here the body readily changes to formic acid and is therefore called formaldehyde. Formaldehyde is readily manufactured from wood alcohol and the gas is readily taken up by water to the extent of forty per cent. The results obtained from experiments in the digestion of foods which contain formaline indicate that it renders the food less digestible than it would be under natural conditions. But as formaline is comparatively new as a preservative of foods, the number of experiments that have been made are not large enough to warrant any definite conclusion. In the experiments made in this series, the formaldehyde was placed in the milk and these samples were compared with samples of milk having the usual quantity of corrosive sublimate and

potassium dichromate so that formaldehyde could be compared with those substances which are at present largely use as preservatives for composite samples of milk.

SERIES NO. I.

The experiments were made with formaldehyde forty per cent. solution. The milk used in the experiments was received directly from the Farm Department of the Station. For each test 400 c. c. of milk were placed in a pint mason glass jar and the quantities of the preservatives added as given in the following table. Duplicates tests were made for each quantity of the preservative. After adding the preservative the jars were sealed and the entire number transfered to the room in which the jars were kept until the end of the experiment; the temperature of the room being recorded each day.

The following results were obtained for the preserving power of the substances:

Number of Jars.	Preservative Used	Amount of Preservative used in Jar.	No. of days which Samples kept before Curdling.
1 and 2.	Formaldehyde 40 per c.	.01 cubic centimet'r	3 days hrs
3 " 4.	" " "	.02 " "	3 "
5 " 6.	" " "	.04 " "	3 " 5
7 " 8.	" " "	.1 " "	4 " 12
9 " 10.	" " "	.2 " "	5 " 20
11 " 12.	" " "	.4 " "	9 " 00
13 " 14.	" " "	1. " "	18 " 12
15 " 16.	Corrosive sublimate.	20 grains	38 "
17 " 18.	Potassium dichromate.	15 grains	34 "
19 " 20.	Nothing		Curdled in less than 3 days.

The experiment continued from July 31st to Sept. 16th. The mean temperature of the room in which the samples were kept was 76. 7° F. The minimum temperature being 65° F., and the maximum 87° F. The samples were tested for the per cent. of the fat every three days by the Babcock method. The test for fat did not show any tendancy to loss due the preservative. When the amount of formaldehyde present is compared with the amount of corrosive sublimate and potassium dichromate it is readily seen that formaldehyde compares favorably with the preservatives now in general use.

SERIES II.

In this series of experiments the same quantity of milk was taken for each jar as in Series 1, and the experiment was carried on under the same conditions. The following table gives the substances used and their power as preservatives:

Number.	Substances used	Quantity in each Jar.	No. of days Preserved (ave. of Duplicates).
1 and 2	Formaldehyde 40 per c.	½ C. C.	14 Days
3 " 4	" " " "	1 " "	18 "
5 " 6	" " " "	2 " "	86 "
7 " 8	Formaldehyde " " " Methyl alcohol	½ " " of each	13 "
9 " 10	Formaldehyde 40 per cent and Methyl alcohol	1 " "	18 "
11 " 12	Formaldehyde in Methyl alcohol	1 " "	15 "
13 " 14	Formaldehyde in Methyl alcohol	2 " "	22 "
15 " 16	Corrosive sublimate	7½ grains	12 "
17 " 18	" "	15 "	57 "
19 " 30	Potassium dichromate	10 "	7 "
21 " 22	" "	20 "	76 "
23 " 24	Blank	—	1 "

One of the objects of this experiment was to test the action of the presence of methyl or wood alcohol, two preparations were used, a mixture of formaldehyde 40 per cent. and methyl alcohol and a solution which was prepared in this laboratory from wood alcohol consisting of formaldehyde and wood alcohol. The results of the experiment indicate that the presence of methyl alcohol does not increase the action of the preservative. The milk in this series of experiments was tested for the amount of fat present every three days for the larger part of the experiment, and the remainder of the experiment less frequent. The results of the determination show that there was no loss of fat due to the preservative. The formaldehyde has the tendancy during the first part of the experiment to cause the casein of the milk to desolve with some difficulty in the ordinary sulphuric acid used in the Babcock test, but later in the period this tendancy seems to disappear.

The jars of milk containing potassium dichromate were in a flakey condition at the end of the period, while those

containing two cubic centimeters of formaldehyde remained in excellent condition without the appearance of any flakey material whatever. This series of experiments continued from Aug. 16, to Nov. 6, 1895. The temperature of the room in which the experiments were made averaged 74.1° F. with a maximum of 87° F. and a minimum of 62° F.

SERIES III.

In this series of experiments the object was to test the preservatives under the same conditions as they would be used in the composite samples in the creamery. The jars were numbered, the preservatives placed in each as shown by the following table, and 15 c. c. of milk added each day after which the jars were rotated.

Number.	Substance used	Quantity in each Jar.	No. days Preserved (Av. of Duplicates)
1 and 2....	Formaldehyde 40 per cent...	.1 C. C.....	13 Days.
3 " 4....	" " " " ...	.2 " "	17 "
5 " 6....	" " " " ...	.4 " "	22 "
7 " 8....	" " " " ...	.6 " "	33 "
9 " 10....	" " " " ...	.8 " "	39 "
11 " 12....	" " " " ...	1. " "	46 "
13 " 14....	Corrosive sublimate.....	3¾ grains..	21 "
15 " 16....	" "	7½ "	30 "
17 " 18....	" "	15 "	48 "
19 " 20....	Potassium dichromate.....	10 "	24 "
21 " 22....	" "	15 "	33 "
23 " 24....	" "	20 "	47 "

The average temperature during the experiment was 74.4° F. with a maximum temperature of 87° F. and a minimum temperature of 62° F. The jars became filled before the experiment was finished and were kept until they curdled.

Those jars having the largest amount of corrosive sublimate could be readily tested for fat at the end of the experiment while those having potassium dichromate were very flakey. The jars containing formaldehyde 40 per cent. were in better condition than any of the samples.

SUMMARY.

1. From the above experiments there is reason to believe that "formaldehyde 40 per cent" promises to become a preservative for composite samples, while indicating that it has

good preserving powers, it has in its favor the following facts. It is not poisonous though it may be disagreeable if taken into the mouth in its strongest form. It is readily measured and handled.

2. One cubic centimeter gives promise to be sufficient to preserve the usual quantity for the time that a composite sample is usually kept at ordinary temperatures, while two cubic centimeters insures the sample during very warm weather.

3. The condition of samples with formaldehyde 40 per cent. appears to be much better for testing than those preserved by other substances: In some cases the casein appears to be less readily soluble in the acid, but this is during the first portion of the experiment, while after keeping for some time this disappears and then there is a favorable comparison with the other samples.

Those who may be interested in testing "formaldehyde" as a preservative for composite samples in the creamery can have the station send them free of charge samples for testing, provided that a report will be made to this station giving the results of their observations, as it is the desire to give the substance a thorough test, both in the laboratory and in the creamery. These samples can be obtained by addressing

CHEMICAL SECTION,
Experiment Station,
Ames. Iowa.

NOTE—The Chemical Section of the Experiment Station expects to investigate the soils of the State, which appear to contain substances that hinder the production of average crops, and with this object in view would like to have those having such soils on their farms to write the Section giving the area of such soils and the position of the soil on the farm with their addresses, also stating if willing to send samples, when desired, for purpose of investigation. Any additional information regarding soil supposed to be alkali soil will be gladly received.

Address

CHEMICAL SECTION.
Experiment Station,
Ames, Iowa.